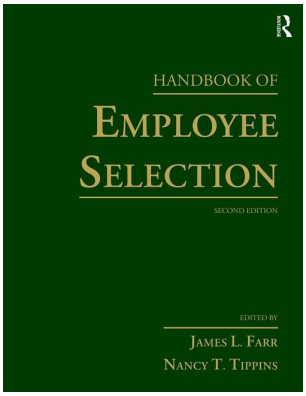

Handbook of Employee Selection

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39

TECHNOLOGY AND EMPLOYEE SELECTION

An Overview

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The practice of employee selection has become heavily dependent on software and the technology systems used to deploy it. Once an administratively burdensome process, selection is now supported by a variety of technologies that are designed to engage candidates while assessing their suitability for employment. A hiring process might now begin with a social media contact, seamlessly screen online for basic qualifications, route acceptable candidates to an online test, and invite those who pass to an in-depth assessment; technology will support each of these steps, as well as the interviewing process and eventual onboarding into the organization.

The rise of these technologies has been driven by the need for cost reduction, the desire to improve an imperfect organizational function for strategic advantage, and a large dose of venture capital flowing into the software development industry. Can technology improve the manner by which organizations select their next generation of associates? The answer is surely positive, but the use of technology-enabled selection tools is also accompanied by a variety of challenges and recurring issues.

Writing about technology for traditional media can be a folly; technology development cycles are far shorter than the publication process, and new technologies may become commonplace or obsolete within just a year or two. Fads are the norm with technology, so popular and novel techniques today are quickly replaced by tomorrow's innovations. Nonetheless, a reader interested in modern selection practices should be aware of the classes of technologies available and the likely direction of their evolution.

Despite the rapid pace of change, some challenges and opportunities tend to be enduring. In this overview we isolate and review these recurring issues that arise when technology-supported selection procedures are used. The potential benefits of using these tools only accrue if the technology is effectively implemented and used, so implementers need to recognize and handle the recurring challenges and opportunities that surface along the journey. These issues may be represented as a set of questions that should be answered as new technologies are designed and implemented:

- Is a new technology compatible with more familiar formats and tools? This question is often posed as one of equivalence, with a key issue centering on whether a new technology introduces irrelevant variance into the results of an assessment process.
- Under what conditions and circumstances will users get access to the selection tools? The options available for deployment have broadened but still involve some basic choices about whether tools will be open for any user, if administration will be supervised, and if users will be authenticated.

- How will the technology systems be implemented within the broader context of the organization so that they will be accepted and used? Effective implementation is likely to have a bigger impact on the value of the system than any specific feature or capability.
- Will the system be deployed across broad geographic, cultural, and/or national boundaries? One of the clear benefits of technology-based HR systems is that they allow for globalized operations. However, global deployment adds new layers of complexity to a selection process.
- Technology-based assessment and selection systems generate a lot of data; some of these data are personal and sensitive. How will data be maintained and kept secure? Are systems designed and maintained with an eye on compliance with global data privacy regulations?
- Do new technologies allow for the new ways to assess people for jobs? How can organizations pick through the many fads to see which innovations might stick and which ones will not?

In this chapter, we will review each of these questions in more detail. To establish context, we first provide an overview of the most common types of technology-based personnel selection system components. Our intention is to set the stage for understanding the challenges raised whenever new technologies are deployed as a backdrop for the subsequent chapters in this section.

TECHNOLOGY-BASED SYSTEMS TO SUPPORT EMPLOYEE SELECTION

Technology-supported selection tools and supporting systems are popular because they add value to organizations; their contribution stems from a mix of tactical and strategic benefits. On the tactical side, technology-based systems often provide administrative efficiency gains, ease of use, cost savings, and advantages associated with scale and standardization. Their strategic benefits stem from promises of improved insight into job candidate characteristics through better measurement, the ability to generate strong engagement with the process, and, ultimately, information of depth and scope about talent that will help executives build and steer their organizations.

Several types of software systems have emerged to support employee selection processes. It is common to arrange multiple systems together into a multistage process, sometimes requiring applicants to pass each portion before gaining access to the next (multiple hurdle). Although it is rare for an organization to use all of the components of this arrangement, we will use the classic selection funnel configuration as a model for describing the role of each type of system. Figure 39.1 shows the set of systems arranged as if all components were in operation together. In practice, an organization may use only one or two components, often supported by an applicant tracking system. Each type of component is described in more detail in the following sections; readers are encouraged to review the latest offerings by providers of HR technologies because these techniques evolve quickly.

Candidate Sourcing

The first step in selection is the recruitment of individuals for consideration. Recruiting is often considered a separate process, both in practice (recruiters rarely make selection decisions) and in the scientific literatures that tie to these functions. However, the technical systems supporting each should ideally be integrated to allow for efficient operation. The way an organization recruits serves as a first selection decision, although it may not always be acknowledged as such. Most large organizations will publicize a broad recruiting stance—an openness to consider qualified applications regardless of background. In practice, it is also common to see recruitment patterns that emphasize a preference for certain universities, experiences, or other recruitment channels (e.g., Ivy League, military officers, physics majors). These patterns are often established due to a few high-profile successful recruits in the past and have the effect of limiting the applicant pool and potentially creating a discriminatory recruitment pattern.

The introduction of Internet-based recruitment and screening tools allows organizations to sidestep these problematic practices and recruit masses of potentially interested recruits because they are easily screened down to more manageable numbers in later steps of the process.

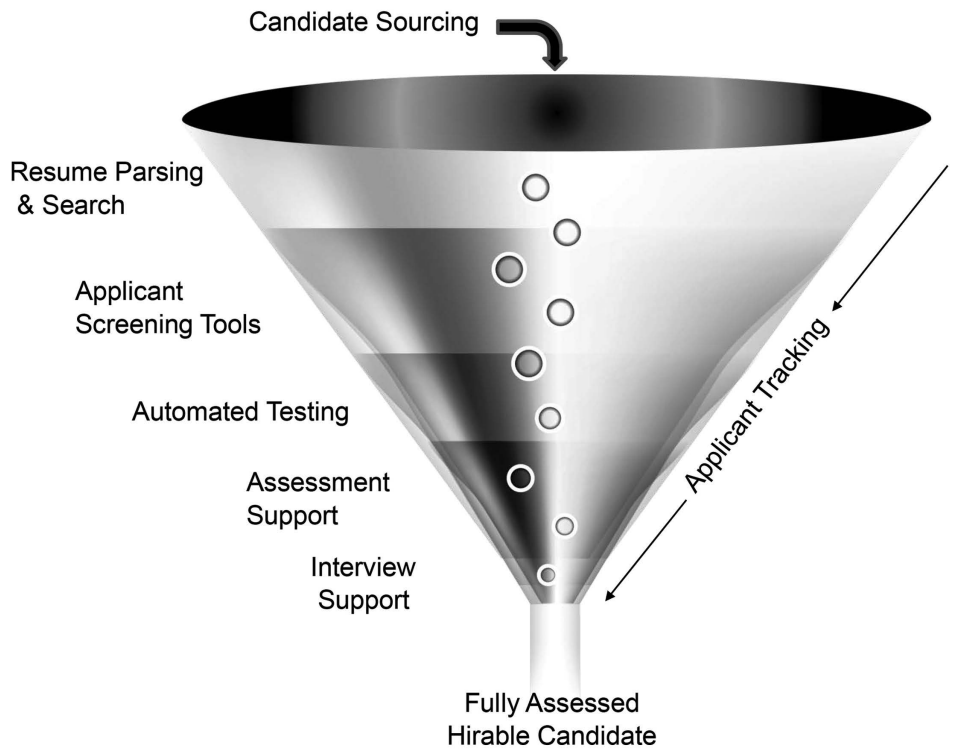

FIGURE 39.1 The Selection Funnel

Screening can be done algorithmically, and checked for validity and unintended demographic deficits regularly and more easily due to the easy availability of the data flow from the process.

There are many technology-centered methods for generating a pool of recruits. Most commonly, a "Careers" tab is built for the organization's website. These sites can be elaborate, filled with videos and other rich content that both describe and sell the benefits of employment at the organization; once interested, the user can begin to submit expressions of interest and qualifications for screening directly on the site. Recruitment then becomes a process of driving traffic to the site from job boards, career fairs, press placements, social media posts, etc.

Some of the more technically sophisticated online recruitment approaches have borrowed a set of functions from the field of marketing automation. These tools allow for detailed tracking of electronic recruiting campaigns to build a list of warm applicants for later outreach. For example, an e-mail campaign may be orchestrated to build a talent pool; electronic interactions with the e-mail are then tracked and tallied to build an interest score for all recipients. Variables such as the open rate, tracked clicks through to linked sites, time on the site, connected topic areas opened, and number of repeat visits can all be tracked and scored. High-scoring prospects may then be contacted with more targeted communications or direct contact by a recruiter. By linking available information from social media accounts, recruitment automation systems are able to start a profile of qualifications and likelihood of interest, success in the selection process and beyond. Similar data can be tracked from social media posts and other online activity. Note that much or all of these activities may be executed outside the awareness of the target candidate. They are simply reading an e-mail or social media post and acting upon it or not. Some research has even demonstrated the ability to reliably score candidates on personality variables based solely on the content of their social media postings (Park et al., 2015).

We expect these techniques to advance and proliferate as the range of trackable activities increases. Currently, attention-grabbing games, brainteasers, social media placements, and

similar techniques are used for collecting lists for recruitment. Essentially any technique developed for the well-funded arena of product marketing can be retooled as a recruiting device and will be if it allows an organization to gain competitive advantage by building a fresh and strong database of possible qualified candidates.

Once a talent pool is created, one of two classes of tools is often used to begin the process of selecting those who meet specified qualifications. One method is centered on the submission of a resume, and the other is based on structured screening questions. Sometimes these techniques are used in combination.

Resume Storage, Parsing, and Search

Resume storage tools are typically built to work in concert with an Applicant Tracking System (ATS), once a resume has been submitted and a candidate record has been established in the database. These tools may also incorporate methods to pull resumes from the millions that are posted to recruitment sites. Resume management tools are designed to mine background and qualifications information to help manage the high volumes of candidates who attach a resume to their submission of interest to the organization. Typical features for these tools include the use of text search and keyword parsing to support various search methods for mining the resume database.

Resume parsing tools will automatically deconstruct the resume and put relevant information, (e.g., contact information, degrees, and educational institutions) and certifications into database fields, thereby increasing the speed and accuracy of searches. Once critical information is gleaned from the resume, keyword search tools can be deployed to assist recruiters in the task of assembling a group of job seekers who meet criteria that can be imposed during a database search. These tools may include advanced technologies that allow the meaning of a word or phrase to be detected from the context in which it appears in the resume. For example, the resume for a financial analyst that worked for the company State Street would parse "State Street" under experience, not as the job seeker's address.

Resume search tools can help improve the efficiency of large-scale recruiting processes, but resumes have severe limitations for providing insight into job seeker qualities. The traditionally brief format of the resume does not reveal the quality of prior work or reflect the learning gained from prior experience. These essential characteristics can best be determined via more advanced screening, assessment, and interviewing techniques.

Applicant Screening Tools

As an alternative or supplement to resume-based tools, structured qualification screening begins by requesting responses to qualification questions that may be scored and used as the basis for candidate ranking. Unlike resume-based tools, where candidates are pulled from a database of broadly collected resumes, screening questions may be constructed to be highly specific to available jobs. When they are designed and implemented effectively, they can provide a standardized method for quickly collecting background and qualifications data on job seekers and sorting them on the basis of their fit or predicted success for specific open positions.

Common questions include work and educational history (some systems may extract this information from a resume and have candidates review and update the extracted information), basic qualifications (e.g., licenses, certifications, and years of relevant experience), and specific experiences (e.g., with equipment, work processes, or business issues common to the job).

The selection of questions and complexity of the scoring system applied to qualification questions of this sort is important to balance against the sophistication of the administrative users. Sometimes an I-O psychologist will guide the design of the tool and the scoring scheme; in other situations, these roles may be delegated to a broader range of system users. Software developers and users may perceive this feature as a benefit, but the flexibility comes with the risk that qualifications are poorly defined; if not carefully designed, basic qualification questions can

be too specific, too strict, or bear little relationship to the target job. Well-designed systems will include role-based access to question construction, scoring, and deployment so organizations can standardize and control their approach to this selection stage just as they usually would for more complex aspects of the section process. It should also be noted that the qualifications screening process supported by these tools has the same validation requirements as any other selection process. The easy configuration of screening questions may encourage casual users to set standards that are insupportably rigorous and lead to indefensible adverse impact when not properly validated.

Automated Testing

Compared with screening tools, testing provides greater insight into individual characteristics by deploying standardized and psychometrically sound instruments that can provide more accurate measurement of constructs that are difficult to index with screening questions alone, such as abilities, traits, and knowledge.

Automated testing systems tend to have several common features. Test takers are typically invited to the assessment by providing them with secure log-in and password information; standardized instructions, help menus, and practice items are then provided to orient them. During the test session, several features are deployed to facilitate test taking, including count-down timers, progress indicators, and other navigational aids. Many test delivery systems simply deploy computerized versions of popular paper-based versions, but test developers are also taking advantage of the broad range of available computing and display capabilities. Tests that use embedded audio, video, and animated graphics as part of the question stimuli are commonplace; response formats that involve hot-spots, drag and drop, and other interactive controls provide a greater flexibility for handling a range of engaging item types. Advances in natural language processing add the potential for free-form responses to be used in these tools. Page-level timing and other measures of attention and performance provide the basis for new aspects of measurement to be investigated as well.

Question presentation and response analysis, once largely limited to classical linear test configurations, have now yielded to the power of more complex psychometric models, such as those reviewed in Chapter 42. Once rare in practice, measures based on Item Response Theory (IRT) now play a regular role in online testing systems due to their advantages for limiting question exposure, mitigating common cheating strategies, and shorter length—all very desirable qualities for online selection tests.

The rise of gaming technologies has also extended the range of tools deployed to measure more complex traits. Game-based psychometrics provide scores on job-relevant characteristics derived from performance on videogame-style tasks (Rampell, 2014). This mix of technology, simulation, and psychometrics has yet to be researched at much depth, so conclusions about the effectiveness and longevity of the technique are premature. Chapter 44 reviews many of the current options in this arena and findings to date. We return to this issue in more detail later in the chapter.

Behavioral Assessment Support

Tools for supporting behavioral assessment, such as work simulations and assessment centers, allow for presentation of stimuli via controlled e-mail inboxes, instant messaging tools, and voice and video mail. The addition of embedded video or audio interactions with live role players allows for the replication of the work environment in a manner that is a better reflection of how modern complex work is performed and has higher degrees of control and standardization than past versions of nonautomated assessment centers. Unlike most of the testing systems mentioned above, behavioral assessment will emphasize response fidelity and target behavioral

competencies in their measurement, such as Planning and Organizing, Communication, Analysis and Judgment, Financial Acumen, etc.

The strength of these systems rests with their ability to deliver work-related challenges and present realistic situations that elicit work-relevant natural behavior. Behavior is then captured online (through constructed responses, such as a response to an e-mail), through recordings, or the production of work products such as project plans. Recorded behavior may be categorized or pre-rated according to algorithms, but the final scoring and report development is often left in the hands of trained assessors, who use the same system to pull responses and provide ratings against common standards. Natural language processing of simulation responses has supplemented assessor judgment and will continue to play an expanding role in behavioral assessment.

These systems are most often used for complex jobs involving leadership, managerial, or executive-level requirements (see Reynolds & Rupp, 2010, for examples of these tools). Some variants have been developed for nonmanagement roles, such as selection in advanced manufacturing facilities where the cost of training is high. In this context, behavioral assessment allows for the reduction of training failures by providing standardized, monitored, and scored simulated production exercises. Heavy computerization of the activities through the use of sensors attached to physical exercise components allows for accurate tracking of complex motor behavior (Byham, 2010).

Interview Support

Automated tools have also been developed to help structure and facilitate the interview process. Interview facilitators often allow for the identification of the rating targets (e.g., competencies, past behaviors), the construction or identification of questions that assess these targets, the assignment of questions to interviewers, and a process for data combination across interviewers (e.g., Chambers & Arnold, 2015). Furthermore, the tools can help with records retention if the interview protocol, summary notes, and ratings are maintained in the system. Many of these steps are geared toward improving the efficiency and standardization of the interview process; if the tool is based on an interview technique that has been well researched and proven, additional insight into candidates may also be gained.

Just as is the case with behavioral assessment tools, interviewing tools now include capabilities for capturing live-streamed video between the interviewer and interviewee. Automated variants using avatar interviewers or video-based question delivery help maintain a degree of situational fidelity while capturing natural responses from candidates. Here again the use of natural language processing will likely drive additional efficiency and standardization into these tools as the technology evolves. Biometric tools (e.g., voice analysis) and facial recognition technologies are also being used in this context to confirm interviewee identity and aid in scoring.

Applicant Tracking Systems

The role of the ATS is to establish and build candidate records as the recruiting and selection process unfolds and to undergird the systems used to deliver each of the selection steps; these systems also manage job openings and candidate flow. The system should collect, track, and report critical information about open positions, candidates, and selection processes to enable the efficient management of recruiting and staffing functions. The ATS also frequently serves as a hub for additional services (e.g., job posting and background checking) to further extend the value provided to the hiring process through automation.

In addition to the main functions of data tracking and management, an ATS will enable reporting on candidate quality and flow rates throughout the staffing process. This allows for computation of effectiveness metrics, such as the success rates of recruiters and recruiting channels, time-to-hire, and the criterion validity of candidate information. Data storage and reporting are also critical for understanding how the system as a whole is operating with respect

to critical outcomes such as the diversity mix of the candidate pool at each stage of selection. These reports are required to support government recordkeeping requirements and to respond to audit and challenge requests.

On its own, an ATS typically provides little sophistication for the measurement of people, so supplemental processes are often added to support the measurement required for strong selection decisions, and these tools are usually required to integrate with the processes and data formats supported by the ATS.

More detailed summaries of available technology systems to support employee selection are available (e.g., Reynolds & Weiner, 2008). Certainly, many other technology-based products exist and many more will be developed. Fundamental issues regarding efficiency, control, standardization, and measurement accuracy will continue to underlie the business value of new approaches. Novelty, user engagement, and marketing will also play a big part in which of these advances becomes popular. Selection system designers will need to evaluate advancements on the basis of the balance between their business value and the risks they might pose as increasingly complex measurement functions become automated and broadly accessible.

COMMON ISSUES ENCOUNTERED WITH TECHNOLOGY-BASED SELECTION

Various technology-centered tools and techniques to support selection will come and go, but the challenges they raise for implementers and users will likely persist. Various factors may contribute to the potential impact of technology. Some of these issues are unique to technology deployment (e.g., the equivalence of assessments across media), whereas others may be inherent to the endeavor of personnel selection (e.g., test security), but their impact may be magnified by the use of technology. In the sections that follow, we review the common practices and research on the issues that arise due to the use of technology in the selection process.

Equivalence

As technology-based selection may utilize a variety of formats and tools, the question of cross-mode equivalence must be addressed. Until about the last decade, the equivalence between paper and computerized assessment was a common concern because computer tests were often derived from legacy paper tools, so the comparability of the psychometric characteristics of the old instrument to the new one was essential to establish. Research supported the paper–computer equivalence of power (unspeeded) cognitive ability tests and noncognitive assessments—in particular, personality and biodata (Bartram & Brown, 2004; Salgado & Moscoso, 2003)—but not speeded cognitive tests (Mead & Drasgow, 1993), where scored differences likely resulted from the examinees' interactions with the test materials and input devices. Other studies indicated the need for continued caution when computerizing some types of tests (e.g., Ployhart, Weekly, Holtz, and Kemp, 2003, on situational judgment tests). Reviewers have urged more within-group, repeated-measure studies of testing modality (Potosky & Bobko, 2004) and more systematic study of the factors that might affect equivalence (Stone, Lukaszewski, Stone-Romero, & Johnson, 2013).

Now with the ever-broadening variety of input devices and operating software, the question has moved on to Technology X versus Technology Y test equivalence, and the importance of understanding in what way, if any, the inevitable new technology introduces undesired test variance. Trying to make a new test approximate older technology to achieve equivalence is likely to be a step backward; it would be better to develop some theoretical groundwork or framework explaining equivalence across testing formats (Potosky, 2008). Borrowing in part from Barry and Fulmer's (2004) theory on the use of communication media, Potosky (2008) offers one such framework, in which the test is the medium of exchange (between providers and examinees), and social bandwidth, interactivity, surveillance, and transparency are factors that influence this exchange. *Social bandwidth* refers to the amount of informational cues that are used, such as the

use of audio to simulate aspects of an interview, and *interactivity* refers to the exchange of information (e.g., rapid, reciprocal, synchronous interactive simulations vs. slow, one-sided, asynchronous fixed-form multiple-choice tests). *Surveillance* refers to the possibility of outside monitoring and *transparency* refers to the fidelity and clarity of the test content that can be conveyed without distraction—for example, by the test controls or interface (Potosky, 2008) and by the environment when mobile technology is used (Illingworth, Morelli, Scott, & Boyd, 2015). Using such a framework will be an improvement on rough classifications by test mode or format (e.g., paper, computer, tablet, and phone), particularly as the technology delivery methods multiply.

The primacy of equivalence analysis as a prelude to broader usage in a selection context is evident whenever new technologies and delivery platforms emerge. The latest wave of comparisons focuses on the use of small platform mobile devices. Several recent studies have compared results from mobile users to those using full-screen platforms such as laptops and desktops. Huff (2015) found scores on a personality measure did not vary between mobile and computer-based administrations using a within-subjects design. Arthur, Doverspike, Muñoz, Taylor, and Carr (2014), using a natural sample of job applicants, similarly found no differences in personality scores across platforms, but scores on a speeded test of general mental ability did vary across the format. However, demographic differences between the format groups as well as the speeded nature of the cognitive measure may have impacted these findings. Morelli, Mahan, and Illingworth (2014) examined construct equivalence across formats and found few differences across mobile and computer platforms for personality, cognitive ability, biodata, and situational judgment measures, but these authors did note mean differences on the situational judgment test, perhaps as a result of text-heavy stimuli in that measure. Similarly, Illingworth et al. (2015) did not find differences across platforms for personality and biodata measures.

Perhaps the most remarkable finding from studies of measurement equivalence across technology platforms is the robust consistency of most measures. Despite the many variables that can be imposed by screen size, keyboard controls, connection speed, browser format and functions, and assorted other potentially moderating conditions, most media comparisons have found few differences in how typical selection measures operate. This observation does not diminish the need to make sensible design decisions and to confirm the equivalence across likely delivery formats, but as long as obvious interactions between assessment conditions and delivery format are avoided, most measures seem to generalize readily across available formats. The availability of responsive web design formats (that automatically scale to the user's media format) should provide additional service to advance this general finding.

Deployment Strategies

How will potential job applicants access the steps used to recruit and select them into an organization? What are the side effects of the procedures used to allow them access? For example, will screening procedures be available to anyone who lands on a corporate recruiting site; and if so, how will you know the person completing the process is the same person who shows up for the interview? These questions have formed the basis for a sizable volume of research and commentary as the use of technology in selection rapidly accelerated in the early 2000s. The options are perhaps best summarized by the International Test Commission's *Guidelines for Computer-Based and Internet-Delivered Testing* (2006). The *Guidelines* delineated four common strategies for deploying Internet-based assessment tools based on the level of oversight and control asserted over the assessment process. In brief, these strategies fall into the following categories:

- *Open access*. The assessment can be accessed via the Internet from any location with no authentication of the user (i.e., proof that the participant is who she/he claims to be) and no direct supervision of the administration of the assessment.
- *Controlled delivery*. The assessment is made available only to known participants (e.g., by sending a one-time access invitation to screened candidates), yet no direct authentication or supervision of the assessment session is involved.

- *Supervised delivery*. The identity of the assessment participant can be authenticated (e.g., by requesting ID, agreeing to video supervision, or passing a biometric test), and there is a degree of direct supervision over the administration.
- *Managed delivery*. The assessment session is highly controlled, often through the use of dedicated testing centers, where there is oversight over authentication, access, security, the qualifications of the administrators, and the technical specifications of the computers used to deliver assessments.

The first two options in the list above are all variations of what has come to be known as UIT (Unproctored Internet Testing), and much has been written about the practical and ethical implications of implementing selection systems where the potential for gaining of unfair advantage is heightened by the delivery conditions (e.g., Burke, Mahoney-Phillips, Bowler, & Downey, 2011; Ryan & Ployhart, 2014; Tippins, 2009). Despite the risks, it can be argued that organizational selection processes have never been perfect; the use of technology to accelerate and broaden the selection process merely amplifies existing threats. Several questions are important to evaluate as the concerns raised by the various access methods are assessed: Is the person responding to a selection step the same person who will show up to work? Have sensitive assessments been compromised and/or has the opportunity to cheat been increased? Are candidates given the same opportunity to perform regardless of how they access the selection steps?

Examinee Identification

There is no foolproof way to verify that the person taking the test on the Internet is the actual candidate, but a number of techniques have been developed to reduce the risk of the substitution of a confederate responder during the selection process. One common technique sidesteps the issue by requiring minimal identification during early selection stages (often deployed with "controlled delivery" techniques), but candidates are warned that similar measures will be used later in the process under supervised conditions and, once the second test is administered, similar scores will be expected (e.g., Burke et al., 2011). These procedures provide some discouragement and safeguards against confederate test takers, but they raise questions about the appropriate treatment of cases where discrepant scores between administrations are found; typically, the most secure administration is treated as the score of record, and no further action is taken to investigate the difference. Of course, imperfect test reliability dictates that a portion of all test takers will receive a different result (e.g., pass or fail) on a second administration of a measure, and the probability of a different result will be higher for candidates who score near the decision cut point.

Technical solutions to the problem of examinee identification have been deployed and will become easier to implement as the required hardware and supporting technologies become more prevalent. Foster (2009) describes several identification techniques ranging from keystroke analytics, where the examinee's typing cadence is analyzed and confirmed across registration and assessment events, to the use of webcams and data forensics, such as the analysis of response patterns and latencies. Many devices are now packaged with cameras and fingerprint readers that can be used for establishing identity. The problem of remote identification will likely persist despite these advances. Careful implementation of the various stages of selection can help minimize issues associated with security and identity compromises, for example, by placing short measures of verifiable biographical information early in the selection process where open or controlled delivery is used. More sensitive measures with a bigger impact on final selection can then be deployed on a smaller population of prescreened candidates under supervised or managed conditions.

Test Security and Cheating

Security is a concern for both the users and publishers of assessments. The user might be concerned about a compromise to a carefully designed process necessitating redesign; test publishers are additionally concerned about the loss of intellectual property and the loss of value of a carefully designed product. Although the test delivery system can block the ability to copy the

test using the local computer's operating system, there is no stopping the determined candidate from using other technology to circumvent these security features (e.g., by taking pictures of the computer screen). Test publishers typically include a statement to which the candidate must agree before accessing the test, stipulating that he or she will take the test honestly and will not distribute the information or risk disqualification. The organization also may attempt to limit access to the test to specific devices, conditions, and time periods, and to candidates who have been extensively prescreened. Strong countermeasures, such as regular web patrols to locate compromised test content on the Internet, are also critical for maintaining the security of testing materials.

Candidates who are motived to cheat can often find ways to do so, and Internet-based testing provides increased opportunity for unethical advantages to be gained. There have been several attempts to quantify the frequency and impact of cheating on test results. In one frequently cited study, unproctored test scores were compared to proctored scores, and when a criterion of 1 standard error of measurement (SEM) score difference across conditions was applied, 7.8% of the subjects were identified as cheaters (Arthur, Glaze, Villado, & Taylor, 2010). These authors later comment that this figure is a likely underestimate (Arthur & Glaze, 2011). Others estimate higher rates of cheating, but the notion of a stable base rate for cheating is probably misguided. Malfeasant test-taking behavior likely varies based on the stakes associated with the exam, the deployment strategy used to deliver it, and the moderation provided by various countermeasures.

The prospect that dishonest test-taking strategies may have a substantial impact on the resulting group of selected candidates has refreshed interest in the use of adaptive testing (e.g., McCloy & Gibby, 2011) and variations such as linear-on-the-fly testing (e.g., Burke et al., 2011). These techniques have the dual benefit of reducing cheating, because each candidate can be given a different set of test quesntions, and increasing security because the exposure rate of each test question can be monitored and controlled.

Test Delivery Standardization

Internet-based test deployment broadens the range of conditions under which tests are taken. Remote deployment strategies inherently limit the ability of the test administrator to control the test environment, leading to situations that may disadvantage some candidates. In addition to the distractions that may be present in an unsupervised setting, hardware and unforeseen software issues may arise. Differences among examinees' computers and Internet connection speeds could affect testing, particularly on speeded tests. The imperfect remedy for this situation is to limit the test to deployment on devices that meet predetermined specifications, a process that can be automated prior to the initiation of the test. This practice has disadvantages because some number of otherwise qualified applicants may be discouraged from continuing with the selection process if the available hardware, software, and connectivity conditions are difficult to obtain. To make matters worse, availability of the required system features may be correlated with the demographics of the candidates (e.g., lower-income candidates may have access only through wireless mobile devices). For this reason, test providers are often reluctant to place strong restrictions on access, thereby increasing the variability in testing conditions across candidates. A common practice for resolving this dilemma is to provide strong recommendations to candidates about the appropriate testing conditions and let the users' judgment guide the degree to which they are able to replicate the desired testing conditions.

As shown in this section, unproctored testing brings ethical issues to the forefront. The threat of cheating or unfair conditions creates an ethical dilemma for I-O psychologists, who have an obligation to ensure the quality and standardization of assessments. Professional standards and guidelines for testing dictate the importance of material security, standardization of the test environment, and the control of factors that may impact test performance aside from the construct being assessed (American Educational Research Association, American Psychological Association, and National Council on Measurement in Education, 2014; Society for Industrial and Organizational Psychology, 2003). However, operational pressures push toward remote deployment methods because they allow employers to efficiently gain insight into job candidates before they are brought on-site for more expensive activities. Selection procedures must balance these pressures to manage the quality and fairness of the programs they design.

Implementation Effectiveness

I-O psychologists must consider a range of issues when implementing technology-driven selection systems, including development, administration, and support. Designing and managing technology-based selection systems involves skills that are related to the analytical, decision-making, and organizational change skills of an I-O psychologist, yet also requires those that are not central, such as business acumen and IT expertise. Development includes making a business case for purchasing or building a solution, acting as an information architect for the new system, and managing the transition to new systems. A model for guiding the choices involved in the implementation of technology-based hiring systems was offered in Reynolds (2011); a synopsis of these considerations is provided in this section.

Justification for a technology system will often rely upon reduction of labor costs and improved efficiency associated with new or improved automation. One of the first considerations in the business case is whether to buy or build. The choice affects the time horizon for the implementation. Now that there are numerous commercial off-the-shelf solutions with a range of functions, organizations may seek the assistance of vendors in making the business case for them (e.g., by sending out a formal or informal request for information (RFI) prior to soliciting bids). When seeking bids, the costs of any customization should be clearly identified to the extent it is possible to do so. Many factors can drive the need for customization, including creating customized score reports, migrating tests or examinee data onto the vendor's platform, and setting up systems that mirror the company's organizational and/or regional structures (Kehoe, Dickter, Russell, & Sacco, 2005). Although many organizations may see benefits to customization, it should also be recognized that there are significant drawbacks, usually in higher upfront costs and ongoing maintenance fees, because the resulting software is divergent from the provider's standard platform. For these reasons, configuration of available options within a system is usually preferable to customization of software. Table 39.1 provides general guidance about the categories of costs associated with technology-based selection systems.

I-O psychologists implementing selection technology within organizations should keep in mind three levels of users with a stake in the day-to-day operation of the system: the candidate, the HR manager or administrator, and the manager or supervisor receiving the candidates (Gilliland &

TABLE 39.1
Costs of Implementing Technology-Based Selection

Source	*Examples*
Development	• Software development, customization, and/or configuration
	• Technology integration (with applicant tracking systems, enterprise resource planning, etc.)
	• Equivalency studies
	• Hardware (as applicable; e.g., computers, tablets, kiosks)
Deployment	• Field testing/quality assurance
	• System hosting fees
	• Installation costs if locally hosted, or costs for software-as-a-service for cloud-based solutions
	• Account setup (process flows, permissions, reporting requirements)
	• Training
Maintenance	• Tracking and reporting
	• Schedules for upgrades
	• Security monitoring
	• Backups and failure recovery

Cherry, 2000). Flowcharts should be developed to map the current and desired processes and features and to understand them from each type of stakeholder's point of view (Kehoe et al., 2005).

The solution's functionality will need to be scalable and flexible. For example, it should be possible to implement the standardized solution without new development or workarounds to accommodate different departments in the organization (scalability). The solution must also be adaptable to meet future requirements and technology upgrades. Kehoe et al. (2005) discussed questions the I-O psychologist should ask when developing a technology-based selection system. These include how the administrative rights to it will be managed, how candidates will gain access to tests, how test security will be assured, whether the system can be configured to apply the organization's test policies (such as retests or disability accommodation), and how test results will be stored and communicated. The organization's available hardware/software and IT infrastructure are also key considerations. The technology's requirements (e.g., operating systems, browsers) must be compatible with the organization's special requirements (such as security protocols and firewalls). Whether the solution is created in-house or procured from a vendor, the IT department must assist with its implementation.

Managing the Implementation

Implementing a technology solution can be a complex project, from the design of the new selection process (as described in other chapters in this volume) to managing the technology. These projects involve software development and database administration, two skills that are not standard in I-O training.

The plan for implementation should include specifications of functionality, whether for building the system or understanding how an off-the-shelf solution will work with the organization's hardware and software. The new system also must accommodate any legacy processes and data. The more complex the organization's technology infrastructure, the more fine-grained the details should be about software functionality. Failing to specify the most critical software requirements ahead of time could delay or derail the project.

Because of the high-stakes nature of selection and the precision required for selection systems, a quality assurance process plan is also essential. The system should be beta-tested to make sure the software functionality is intact and that it is in line with user expectations.

The selection software may also need to integrate with other systems the organization may be using—whether other selection systems or related systems (e.g., applicant tracking or career management tools). Once configured, an application program interface (API) will allow programs to exchange data automatically.

Administration

When administering the system, the organization must pay special attention to the ways in which information is accessed, processed, and stored. Different types of users will have varying levels and methods of access to the selection tools and systems. The organization must have policies detailing when, or if, test information is available to a user (i.e., applicants, HR staff, and hiring managers). I-O psychologists also must decide to what extent the information will be processed by rules and automation, and to what extent HR experts will be involved to make judgments and carry out transactions. The method of storage partly determines the administration possibilities. Example configurations are provided in Table 39.2.

Supporting the Implementation

The selection system will not be a static entity. As technology progresses, the organizational structure changes, and HR processes are upgraded, there will be a need for consulting and

TABLE 39.2

Administration of Technology-Based Selection Systems

Function	*Example Configurations*
Role-Based Access	• External applicants are granted test access only after a screening and approval process categorizes them as viable candidates. • Internal applicants, but not externals, are provided with a feedback report about results. • Hiring managers can access only those candidates who are eligible for interviews. • Test administrators have basic privileges (access to deliver tests and see only pass/fail results). • HR managers can view summary of reports. • Analysts and I-O psychologists can run database queries of raw data and conduct item analyses.
Automation of Rules and Reports	• Business managers and HR generalists can access workforce and adverse impact analyses directly. • Rule-based progression of passing candidates to the next step in the selection process • Automatic communications triggered to candidates and stakeholders based on status within the selection system
Data Storage and Archiving	• Database structure that permits data integration across systems, such as assessments from different vendors • Automatic archiving of assessment data after a specified usable lifespan

dedicated staff time in the form of technical support, ongoing maintenance, and user training. Table 39.3 highlights examples in which each type of service may be needed. When provided by a vendor, these support services should be included in a service-level agreement as part of the contract for the vendor's services.

Importantly, the overarching trend that influences development, implementation, and support is technology integration. Many technology providers are building market share by supporting a broader array of HR functions across the "talent management lifecycle," requiring the integration of data from recruitment and organizational entry through management and career

TABLE 39.3

Support Services for Technology-Based Selection Systems

Service	*Example Needs*
Technical Support	• Services to each major group of stakeholders (i.e., candidates, HR staff, and business managers) • Candidate support: information on testing technology, troubleshooting access to tests • HR staff encountering technical difficulties with aggregate reporting • Business managers seeking guidance about access to reports
Maintenance	• Ongoing maintenance, updates, and revisions (e.g., content and feature changes to hosted websites) that may require downtime • Commonly and increasingly, organizations may need to adjust to an agile development approach where software is updated continuously instead of in occasional bulk releases
Staff Training	• Multiple methods for training, including live sessions, websites with frequently asked questions, and self-guided training modules • Retraining readily available to account for organization changes, software upgrades, staff turnover • Guidance on integrated systems when hiring data are merged with other HR systems

progression. It is reasonable to expect that in the future it will be rare for a technology-based selection system to be implemented and administered in isolation from other systems. Some talent management systems already integrate a broad range of HR data into a single resource planning database for use in making strategic decisions about human capital. This trend has several implications for I-O psychologists. Researchers and practitioners will be able to obtain data that are harder to come by today (e.g., performance and return-on-investment data for use in validation studies, program evaluation, and employee-organization linkage research). Psychologists will be able to earn a broader role in strategy setting and decision making if they are able to provide an analytical, forward-thinking use of the information to help inform organizational decision-making.

Globalization

Technology-based systems enable broader and more standardized application of their selection procedures across a wide geography. This provides many advantages for large organizations who seek to centralize the operation of their selection process. Internet deployment also means selection system designers need to consider a range of cultural factors as these systems are constructed. Caligiuri and Paul (in Chapter 36 of this volume) detail many of the considerations faced by multinational organizations in this regard. Our short summary focuses on an overview of the conditions that systems designers should consider as they deploy assessments over the Internet when applicants across cultural boundaries are expected.

At the root of the potential concerns that arise when selection processes are broadly available over the Internet is the fact that people are being compared (either to each other or to a common standard) when a portion of the differences between them are due to different cultures, languages, or a combination of both of these factors. Unless these differences are acknowledged and managed, the quality of the resulting decisions will be diminished. By attending to the variables across which the selection system is intended to generalize, the potential for bias and harm due to poorly calibrated assessment can be reduced.

The procedures for properly adapting assessments across languages and cultures can be technically complex and time-consuming, and laypersons involved with the selection process will often underestimate the impact of these broad variables as well as the complexity of the adaptation process, creating challenges for the selection practitioner. The professional standards cited earlier, as well as the International Testing Commission's International *Guidelines for Test Adaptation* (2005), describe the obligations for the assessment professional as well as the steps to consider when making adjustments for language and culture. Assuming the job requirements and working conditions are similar across locations, most cross-culture and/or cross-language applications can be supported with techniques such as re-norming to appropriately support the purpose of the assessment, translation (using procedures designed for use with assessment), local validation, and construct equivalence studies when samples sizes allow. Ryan and Ployhart (2014) note in their review that the globalization of selection processes is a recent phenomenon, and there is a great need for more research in this area.

The critical issue for the selection specialist is to recognize the complexities involved and plan a course of research to support the types of comparisons and generalizations being made. One recent study (Lievens et al., 2015) examined a myriad of issues involved with transporting a situational judgment test across cultures; after careful translation and comparability analyses, the measure was found to operate with a reasonable degree of consistency across two cultures, but the study provides a detailed example of the issues that can arise as tests are generalized in this manner.

Data Usage

As the use of the Internet for recruitment and selection extends the reach of these processes to a worldwide audience, organizations must be compliant with the various international rules that

apply to the transfer of individual data across national borders. The political and legal context for online privacy and data security has become more complicated in recent years, as high-profile data breaches have become commonplace and revelations of government-supported data monitoring have become public. These incidents expose the different approaches various countries have taken toward privacy protections for their citizens.

Perhaps the most advanced framework for data privacy was established by the European data protection regulations. These rules are relevant for technology-based selection systems because they govern cross-border transfer of personal information. For example, online tools that allow job seekers in Europe to apply for a job in Europe might be hosted on computers located in the United States; this process involves collecting personal data and transferring these data across borders. By engaging in this activity, an organization could potentially be in violation of the domestic laws of the European Union (EU) Member States. These laws were implemented as a result of the EU Directive on Data Protection, which aims to prohibit the free flow of personal information from EU nations to countries that have been deemed to have inadequate privacy protection, such as the United States.

The Directive, which went into effect in 1998, underscores the difference between both the cultures and legal systems of Europe and the United States. In Europe, privacy protection is viewed as a personal right. To protect this right, the various EU Member States have, over the past several decades, enacted legislation administered through government data protection agencies. The Directive's primary intended purpose is to set minimum privacy protection standards for each of the EU Member States and to make it easier to transfer personal data within the EU. In the United States, by contrast, the protection of private information is viewed less uniformly, with differing standards for varying circumstances; therefore, privacy protection in the United States is guided more by limited legislation and regulation, and by self-regulation.

Organizations that seek to deploy Internet-based HR systems that involve international data transfers have several compliance options. Two approaches are common. First, organizations can establish a data handling agreement under contract directly with their European partners and/or clients that governs how data will be handled. As long as the procedures are consistent with EU regulations, the data transfers handled under these contracts are allowed. Second, U.S.-based organizations may join a U.S. Department of Commerce program that certifies them as a safe harbor for personal data. This certification states the organization's willingness to adhere to seven Safe Harbor Privacy Principles that the Commerce Department negotiated with the EU. This program, and the EU laws to which it relates, are described at www.export.gov/safeharbor. Unfortunately, the status of this program was challenged in 2015 by a European court ruling that disallowed the Safe Harbor under EU law ("The Court of Justice," 2015). At the time of this writing a revision to the program has just been developed and is in the process of being implemented. The core privacy principles upon which the EU laws were based remain intact, but the new regulations require enhanced transparency and monitoring, and the penalties that may be imposed by EU authorities are now substantially higher ("European Commission unveils EU-US Privacy Shield," 2016).

In brief, the seven privacy principles that form the basis for allowable data transfer are as follows:

1. *Notice*: Individuals must be informed, as early as possible and in unambiguous language, about the organization's reasons for collecting and using their personal information.
2. *Choice*: Individuals must be allowed to decide if and how their information is to be used or disclosed to third parties beyond the purpose originally specified and authorized by the organization collecting the information.
3. *Onward transfer*: Personal information may only be transferred to a third party under the Notice and Choice conditions specified above. One organization can transfer data to another without participant assent only if the third-party organization is also qualified as a safe harbor or otherwise satisfies the requirements of the Directive.
4. *Access*: Within logistical reason, individuals must have access to and be able to correct, add to, or delete their personal information where it is deemed inaccurate.
5. *Security*: Data must be reasonably protected from loss, misuse, unauthorized access, and disclosure.

6. *Data integrity*: Personal information must be relevant, reliable, accurate, current, complete, and used only for the purpose for which it was collected and authorized by the individual.
7. *Enforcement*: Organizations must provide mechanisms for complaints, recourse, and procedures for verifying adherence to the safe harbor principles remedying any problems.

The liabilities associated with these responsibilities need to be carefully examined with respect to any HR processes, and online recruitment and selection processes are of particular concern because of their broad reach to the public at large. Companies that use online recruitment and selection processes should be aware of these privacy considerations and take steps to ensure their online tools are compliant with the latest legislation in the regions in which they operate; otherwise, Internet-based systems that collect information broadly from job seekers will raise substantial risks associated with liability for data processing and transfer.

New Measurement Methods

This is an exciting time for selection system developers and researchers, as the amount, variety, and interconnected nature of data bring new opportunities for measurement and for improving validity of selection procedures. Chapter 44 covers some emerging technologies in detail, though it is impossible to know what other innovations might be germinating at a technology firm's laboratory (or in an entrepreneur's garage) that could have implications for selection. This section skims the surface and offers a few observable themes. Awareness of current trends and emerging themes will help I-O psychologists apply new technology to selection and assessment systems, as well as to lead implementation and research efforts that are cutting-edge, theory-based, valid, practical, and fair.

How can technology continue to enhance the practice of assessment? A few themes are apparent from progress that has been made already. Technology can be used to collect more data faster and aggregate it into bigger data sets than we have worked with before. It will support the development of more powerful analytic and algorithmic tools, and it can enable the collection of smaller slices of behavior or wider samples of behavior. Technology can alter the stimulus or response format to increase fidelity or engagement. It can gather new types of response information in new contexts that could assist with measurement. Technology can also support greater interconnectedness across other organizational functions. These possibilities are evident by advancements already being witnessed in some assessment contexts:

1. *Data Supply*: The promise of large amounts of data, perhaps replenished frequently, whether from within an organization or gathered from Internet sources, will transform how we work and live. Social media will continue to connect our professional and personal lives, as statements we make publicly online are put to use in understanding our personalities, interests, potential for success at work, and predicted attraction to specific job openings.
2. *Aggregation:* A related theme is the centralization of data. It is becoming common for organizations to link assessment and other HR data (e.g., learning and development processes) with enterprise data to demonstrate how talent pipelines help generate organization-level outcomes. Aggregation may also take place in the broader economy, with centralized marketplaces (e.g., LinkedIn) matching candidates and competencies to job opportunities and recommending avenues for professional development.
3. *Analytics and Algorithms:* New analytic techniques and software will need to be developed to process the tremendous supply of data. Innovations could encompass everything from machine learning to improved predictive algorithms to the use of increasingly complex artificial intelligence (AI) programs. (It is tempting to speculate on the extent to which such AI might one day be involved in the research and development cycle, from meta-analysis of published empirical findings to model development, assessment delivery, analysis and refinement, and in the publication of results. How much of an educated individual's job, including that of an I-O psychologist, might one day be aided by an artificial agent?)
4. *Novel Data Types and Micro-behaviors:* We are able to collect information in small bits and from different devices and integrate this information. Micro-behaviors such as mouse-over hover times (the time spent with a mouse above a link before deciding to click it or not) and response latencies are currently observable, and new uses for current devices are possible (e.g., smart phone accelerometers that measure movement for motor skills assessment), but soon there will be other, more complex

responses that can be interpreted by a computing device, such as eye-tracking and facial recognition of micro-expressions. We will grow accustomed to data collection and connectivity between everyday devices that will contain computer chips that will feed connected databases. Wearable technologies bring both the possibility of biometric data (e.g., heart rate) and control methods (e.g., brain wave sensors/biofeedback to control devices).

5. *Virtual and Augmented Reality*: High-fidelity simulations will become even more realistic, and where desired, information may be provided to a virtual-reality test taker (e.g., labels on objects in view) to augment the experience, whether to clarify or to enhance its complexity. One can imagine how the stimulus- or response-fidelity of a virtual experience, with video, audio, and other sensory information, could transform the realism of a work-sample simulation and inspire the participant to perform more as he or she would in a natural setting.
6. *Gamification*: As concern over applicant reactions to technology (e.g., Bauer, Truxillo, Mack, & Costa, 2011) yields to competition over applicant engagement, there is increasing interest in using game-like features in the hiring process. It may become common to use games as passive recruitment tools or as low-stakes assessments. Candidates might not know that a particular activity, perhaps a learning game, contains an assessment, or even that they are being recruited to become a candidate. This trend is explored at length in Chapter 44.

Whether or not each of these themes could describe a selection technology that one day results in improved predictive validity remains to be seen, and all have practical constraints and ethical considerations to take into account. In some cases, a particular innovation also may cut across one or more themes to provide solutions that are truly new and change expectations regarding the validity and utility of selection systems.

CONCLUSION

Looking ahead, the practice of employee selection can be expected to continue to experience rapid change as a result of technology advancements. The chapters in this section of the Handbook consider the critical issues provided in this chapter in more detail, such as the cybersecurity of selection processes amid persistent threats from determined hackers (in Chapter 41), the current availability of Big Data sources and analytic techniques for mining information about candidates and employees (in Chapter 43), the implications for employee selection of proliferating mobile devices and gamification of organizational systems (Chapter 44), and updates on the latest advancements in job classification in a technology-fueled labor market churning out new types of jobs (Chapter 40). This chapter and those that follow should be read with the caveat that it is challenging to survey a changing landscape that outpaces the research literature. Much of the existing literature that deals with technology in the hiring process is results-focused and practice-oriented, so there is great opportunity for programmatic research and the development of related psychological theory. To generate further research interest, we have highlighted some of the issues raised in this chapter in the categorized list below.

- *Equivalence:* Use within-group, repeated-measure studies of technology-based tests and assessments to investigate equivalence of assessments on multiple technology modes of administration.
- *Assessment Environment*. Using quasi-experimental field studies, classify the factors in test modality (e.g., delivery technology, administration environments such as mobile access) and usage conditions (e.g., proctored/unproctored, high-stakes) that influence scores, pass rates, and validity in order to develop a taxonomy of influences and acceptable administration protocols. Develop and test theory-based explanations for underlying similarities and differences.
- *New Measurement:* Determine the assessment value and opportunities added by virtual-reality simulations, tracking various micro-behaviors, and using novel assessment data types including biometric data.
- *Big Data, Aggregation, Analytics, and Algorithms*: Study the practicality, benefits, and ethics of the use of the data that are being amassed from the Internet.
- *Applicant Engagement*: Study the conditions that lead job seekers to engage with and persist in assessment processes. How can longer interactions with technology-based assessment systems be encouraged in order to provide more data to support the validity and insights derived from the experience? How can potential applicants be identified and drawn into the process more easily?

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